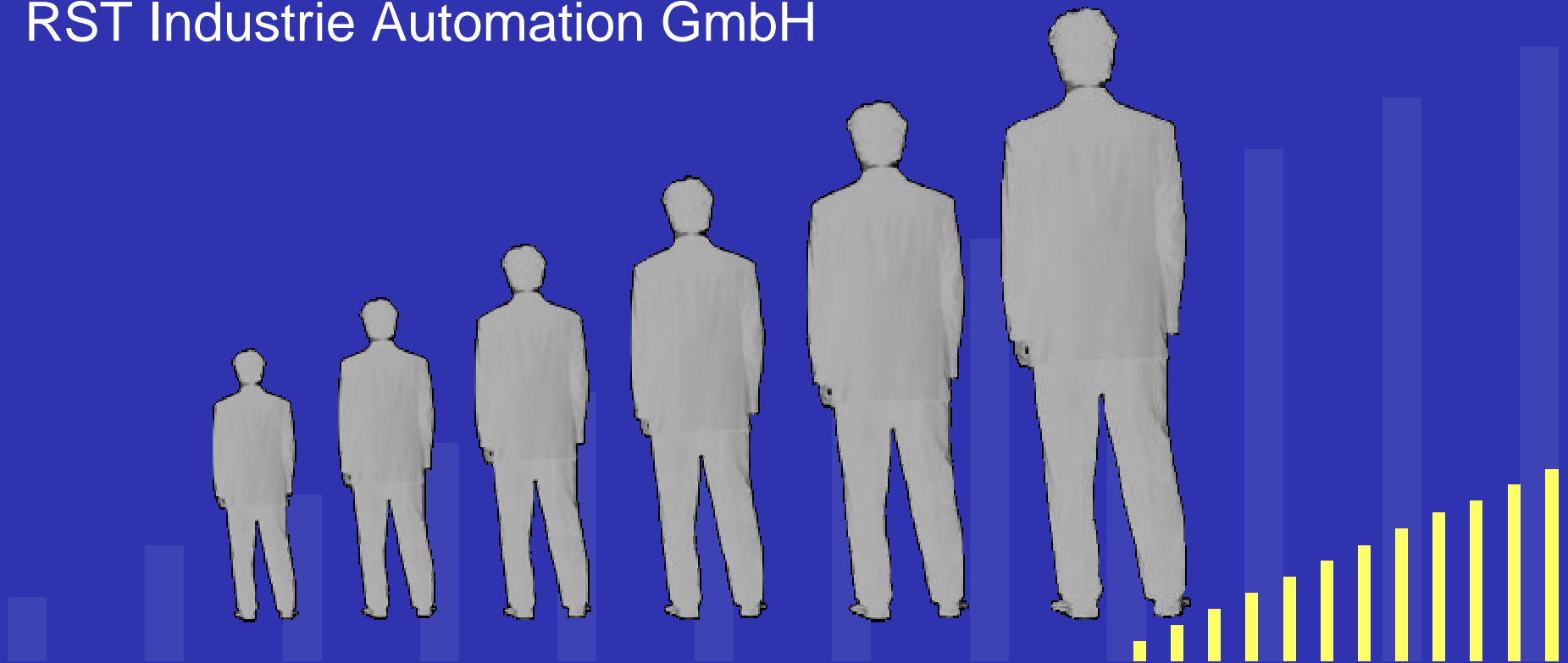


Hard Real-time in medical applications
Immense increase of programming efficiency with
the GAMMA development tools

OS-9 Technology Day

Dipl.-Ing.(FH) Sascha Grewe
RST Industrie Automation GmbH



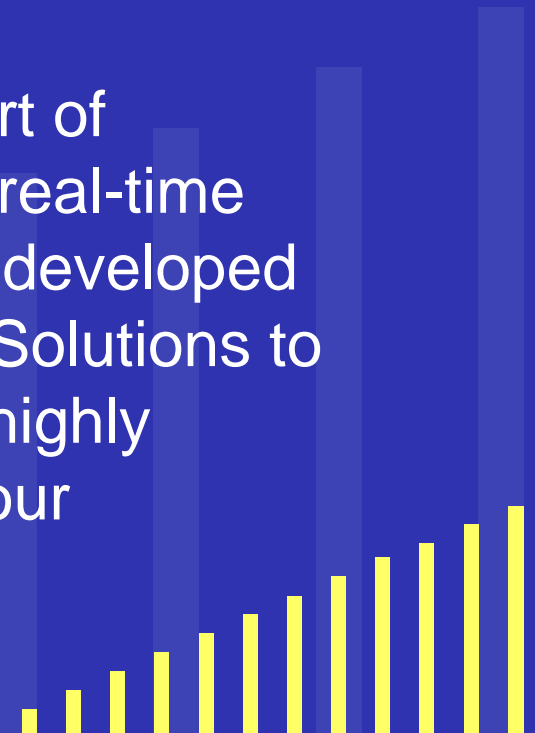
History



The experience of the company has its origin in the year 1987. This was the year where we started to develop object oriented real-time tools. 1989 we have presented one of the first window based process visualization.

-With this staff a new base was formed in 1993. The head office

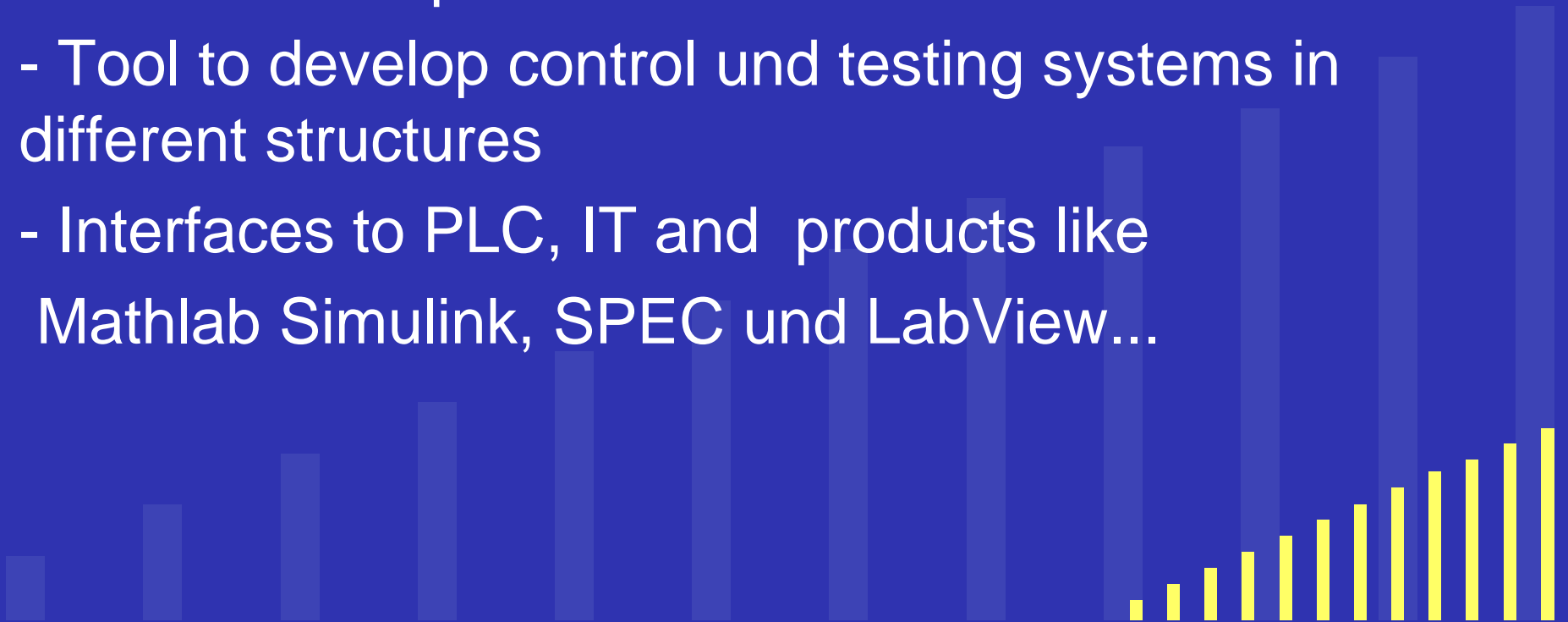
-is located in Ottobrunn near Munich, the "heart of Bavaria". 1994 we started to develop the new real-time software product gamma. Since now we have developed nearly 200 different Systems from embedded Solutions to complete control Systems. At the moment 15 highly specialized people develop now solutions for our customers.



What is Gamma?

Gamma is a Cross development Tool for:

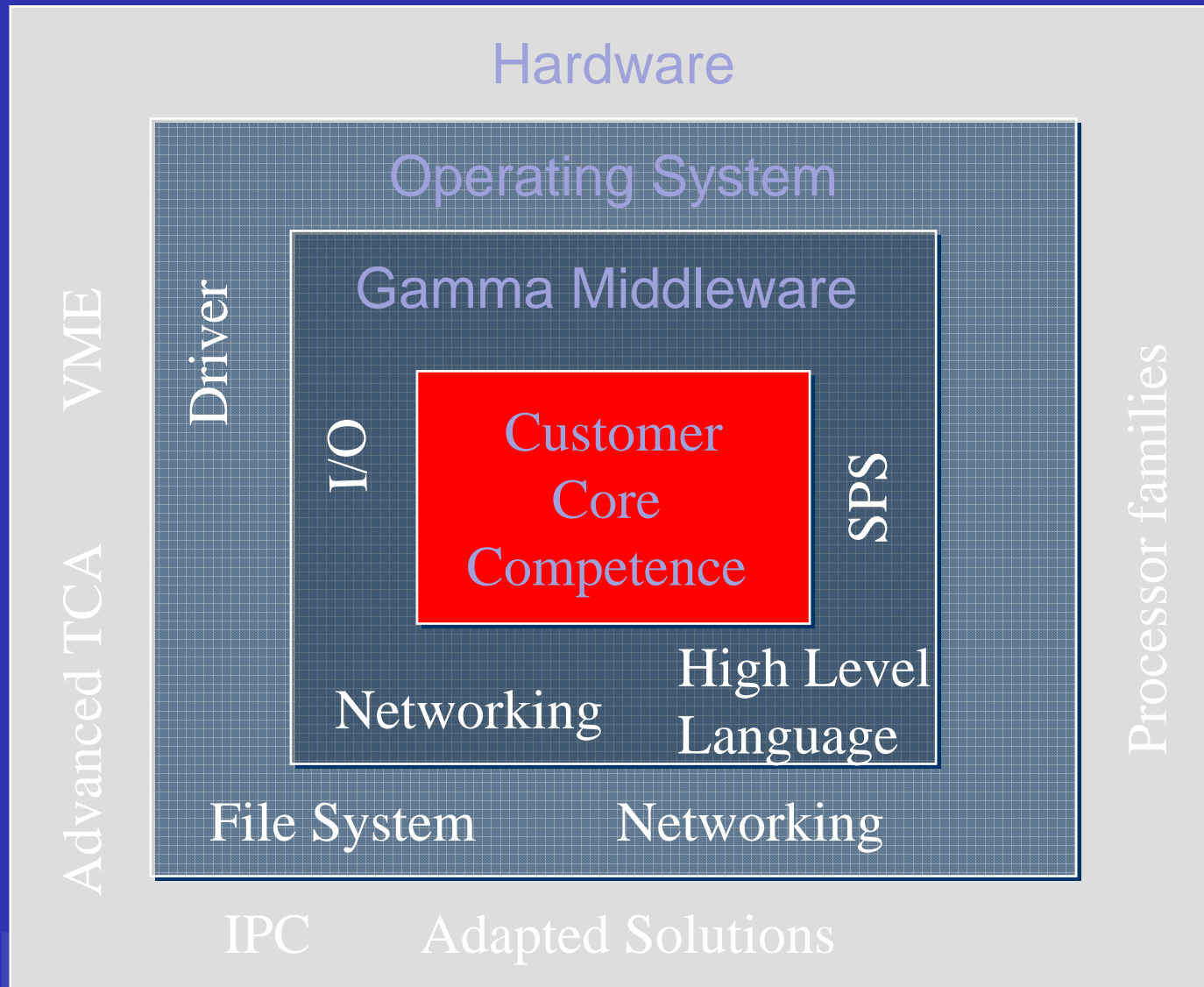
- Distributed applications
- Preferred in Real-time
- Platform independent
- Tool to develop control und testing systems in different structures
- Interfaces to PLC, IT and products like Mathlab Simulink, SPEC und LabView...



Our Advantages

- The hardware is much better than classic PLC's and standard PC's
- There are innumerable platforms available
- Customers can change between different Hardware Developer
- No dependencies
- Embedded Hardware is mostly cheaper
- Real-time Operating Systems are more flexible
- Software can be transferred easily to new platforms
- Programming with Gamma can be much more effective

We optimize the customers work



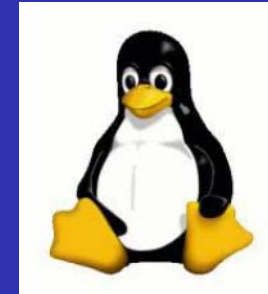
Gamma combines the advantages of PLC and IT

Gamma could be the missing part to become a complete solution



- Easy, transparent and fast programmed like a PLC
- Flexible and powerful like IT Products

Gamma platform concept



- Developing operatingsystem and Hardware independent
- Common maintenance
- Simple porting

Process development



Logik

IVS/OVS/Code Desc

Function Header & File Name & Documentation

CHKCPYTASK(@oidx, @iidx, @cnt)
CHKCPYTASK.gst

IVS

InTid	TID
CPYALIVE	CopyTaskAliveCount
MAXTO	MaxTimeout
ACTCPYTIMER	ActCpyTimer
LASTCPYVAL	LastCpyTimeValue
CPYALIVEOK	CpyTaskisRunning

OVS

ObjName	TID
---------	-----

```
16 /*      | 11.10.05 |  SJG      | Writing the initial version
17 /*      +-----+-----+-----+
18 /*
19 /*      (C)copyright since 2003 by RST Industrie Automation
20 /*
21 /*****
22 /* Check the alive counter of the copy task. A flag (CPYOK) indic
23 /* state of the task:
24 /* CPYOK = 0      Process isn't running (errorcondition)
25 /* CPYOK = 1      Process is running (normal operation)
26
27 if (CPYALIVE!=LASTCPYVAL) then
28     ACTCPYTIMER=MAXTO
29     CPYALIVEOK=1
30     LASTCPYVAL=CPYALIVE
31 else
32     if (ACTCPYTIMER<=0) then
33         CPYALIVEOK=0
34     else
35         ACTCPYTIMER=ACTCPYTIMER-1
36     endif
37 endif
38
```

Structured Text for simple control sequences

... Or „C“ / „C++“



IVS/OVS/Code Libraries Desc

Function Header & File Name & Documentation

..\..\30.NOD\TASK\1.OBJ\StaticLink.c

IVS

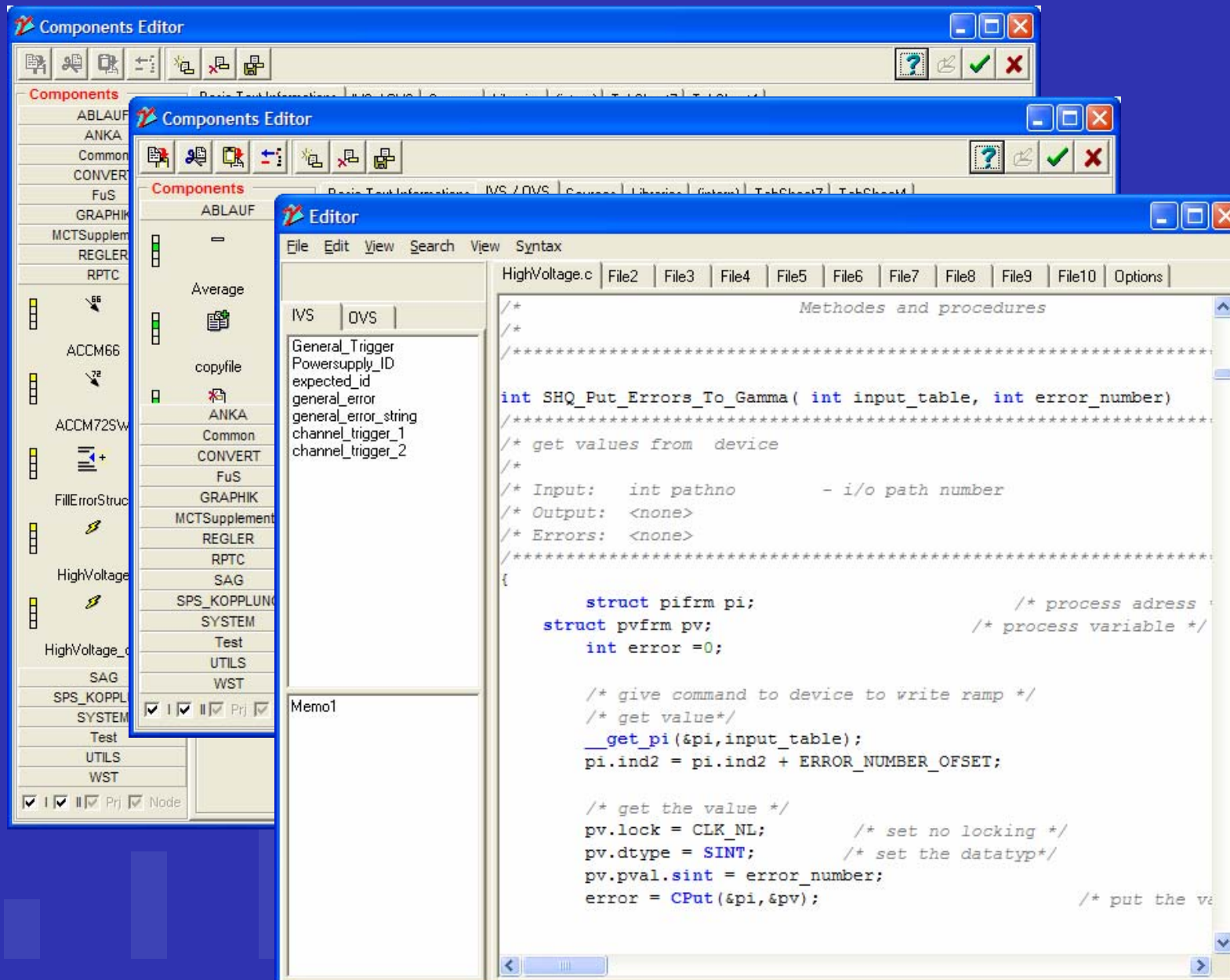
InTid	TID
ROOMID	Room
PATIENTID	patientID
SPOTSDONE	NumberofSpots_dor
MAGNETPSID	PowerSupplyMagne
SPOTDATA	TherapyResultSpotD
LOC_ROOMID	Room
LOC_PATIENTID	patientID
LOC_SPOTSDONE	NumberofSpots_dor
LOC_MAGNETPSID	PowerSupplyMagne
LOC_SPOTDATA	TherapyResultSpotD

OVS

ObjNme	TID

```
70 error_code iLinkStaticLayer (struct grShiftData *rSTLayer, int iLink)
71 /*****
72 /* Connects a predefined structure (see interface.h) to Gamma pr
73 /* This structure contains the layer-/shift data which are store
74 /* memmory
75 /* Input:  struct grShiftData *rSTLayer          interface str
76 /*        int    iLink          Link to target (MEMSTAT=Static,
77 /* Output: struct grShiftData *rSTLayer          (Initialized s
78 /* Errors: NOERROR,PARAMETERINVALID
79 /*****
80 {
81     int iError=NOERROR;
82     struct pifrm rPi;
83     struct pvfrm rPv;
84
85     switch (iLink)
86     {
87         case MEMSTAT:
88             rSTLayer->uiRoomID=(u_int32 *)__CGetAddr(ROOMID, U
89             __get_pi(&rPi,PATIENTID);
90             /* rSTLayer->strPatientID=(int8 *)__CGetAddr(PATIE
91             rSTLayer->ssNumberofSpots=(u_int16 *)__CGetAddr(SP
92             rSTLayer->ucMagID[MAGX]=(u_int8 *)__CGetAddr(MAGNE'
```

Component development



I/O Assignment – Device configuration



RST Project Creator 2006

Project

- IO-Assignment
 - VMEBus
 - MVME3100**
 - VME58
 - A201
 - M27
 - M27
 - M31
 - M31
 - VME Slot 3
 - VME Slot 4
 - VME Slot 5
 - VME Slot 6
 - VME Slot 7
 - VME Slot 8
 - VME Slot 9
 - VME Slot 10
 - VME Slot 11
 - VME Slot 12
 - VME Slot 13
 - VME Slot 14
 - VME Slot 15
 - VME Slot 16
 - VME Slot 17
 - VME Slot 18
 - VME Slot 19
 - VME Slot 20

Available Cards

ElmaTrenue
Janz
MEN
Motorola
MVME3100
MVME6100
MVME6110
OMS
Otis
WinTest
Manufacturer

Manufacturer: Motorola Info

TID: MVME3100

Connection Type: VMEBus

Manuals: [View Manual](#) [w Online H](#)

Accepted TOS / CPUs: OS9 / 68000
OS9000 / PPC

Description: VMEbus-CPU mit 320 MB/s ZeSST Businterface und MPC8540 PowerPC CPU für kostensensitive Anwendungen
Die MVME3100 bezieht ihre Rechenleistung aus einem MPC8540 System-on-Chip (SoC) Prozessor von Freescale. Das System-on-Chip Konzept verleiht dem Board einen großen Vorsprung bei der Zuverlässigkeit, Produktlebensdauer und dem Wärme-Design gegenüber Industrie-PCs. Der Prozessor integriert CPU-Kern, Speicher-Controller, PCI-X Buscontroller und Gigabit Ethernet Schnittstellen in nur einem Chip. Dabei liegt die Leistungsaufnahme des Bausteins unter 7 W.

I/O Integration Management



RST Card Integrator 2006

Card Information | IO Settings | Modules | Source Code | Variable Management

ElmaTrenue
Janz
MEN
A12
A201
M27
M31

TID: M27

Online Help: <http://www.men.de/products/>

Connection Type: MModule

Manual: 04m027-.pdf
Add Manual Delete Manual ShowManual

TOS / CPU

OS9	68000	X
OS9000	PPC	X
LINUX	X86	
WINDOWS	X86	
LYNXOS	X86	

Description: 16 outputs 8..36V
500mA output current per channel
Thermal and short-circuit protection
Load on supply voltage
Optical isolation

The M27 is based on the M-Module ANSI mezzanine standard. It can be used as an I/O extension in any type of bus system, i.e. CPCI, PXI, VME or on any type of stand-alone SBC. Appropriate M-Module carrier cards in 3U, 6U and other formats are available from MEN or other manufacturers.

The M27 with its open-collector outputs can be used in process I/O applications (cf. M28 with open-emitter outputs). If there are currents of above 500mA an intelligent power switch guarantees that the respective transistor is switched off. The M-Module is equipped with suppressor diodes for protection against overvoltage caused by inductive loads. The output registers can be read back.

Motorola
QMS
Otis
WinTest

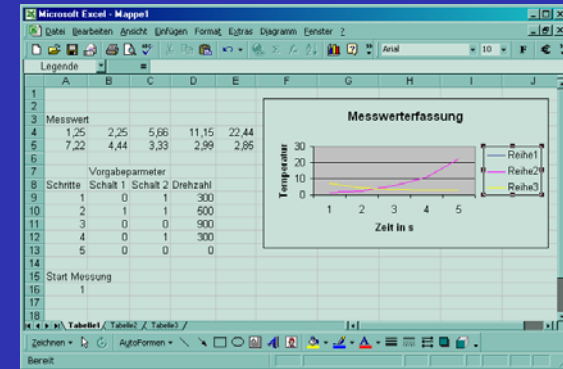
Windows platform opportunities

Borland® Delphi® 2006
The Ultimate I

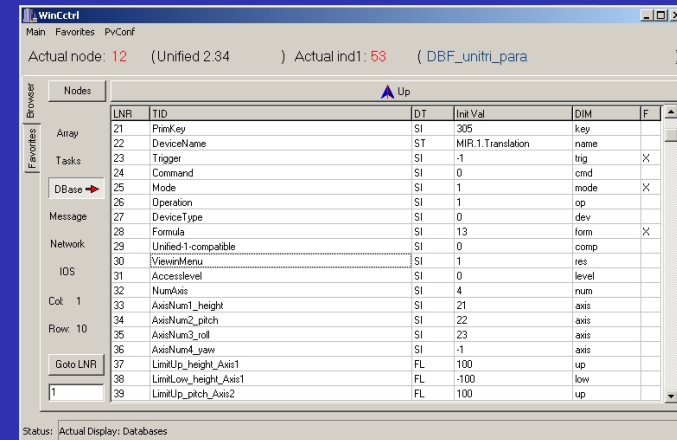
MAXIMIZE I
WITH TH

Borland® C++Builder® 2006
The Ultimate C++ IDE for Microsoft® Windows® Application Delivery

MAX
Microsoft®
Visual C++ 2005
Express Edition



Office/Excel

WinCtrl

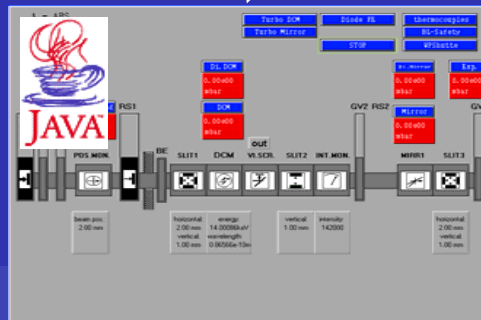
Main Favorites PvConf

Actual node: 12 (Unified 2.34) Actual ind1: 53 (DBF_unitri_para)

LNR	TID	DT	InitVal	DIM	F
21	PinKey	SI	305	key	
22	DeviceName	ST	MIR.1.Translation	name	
23	Trigger	SI	-1	trig	X
24	Command	SI	0	cmd	
25	Mode	SI	1	mode	X
26	Operation	SI	1	op	
27	DeviceType	SI	0	dev	
28	Formula	SI	13	form	X
29	Unified1-compatible	SI	0	comp	
30	ViewerMenu	SI	1	res	
31	AccessLevel	SI	0	level	
32	NumAxis	SI	4	num	
33	AxisNum1_height	SI	21	axis	
34	AxisNum2_pitch	SI	22	axis	
35	AxisNum3_roll	SI	23	axis	
36	AxisNum4_yaw	SI	-1	axis	
37	LimitUp_height_Axis1	FL	100	up	
38	LimitLow_height_Axis1	FL	-100	low	
39	LimitUp_pitch_Axis2	FL	100	up	

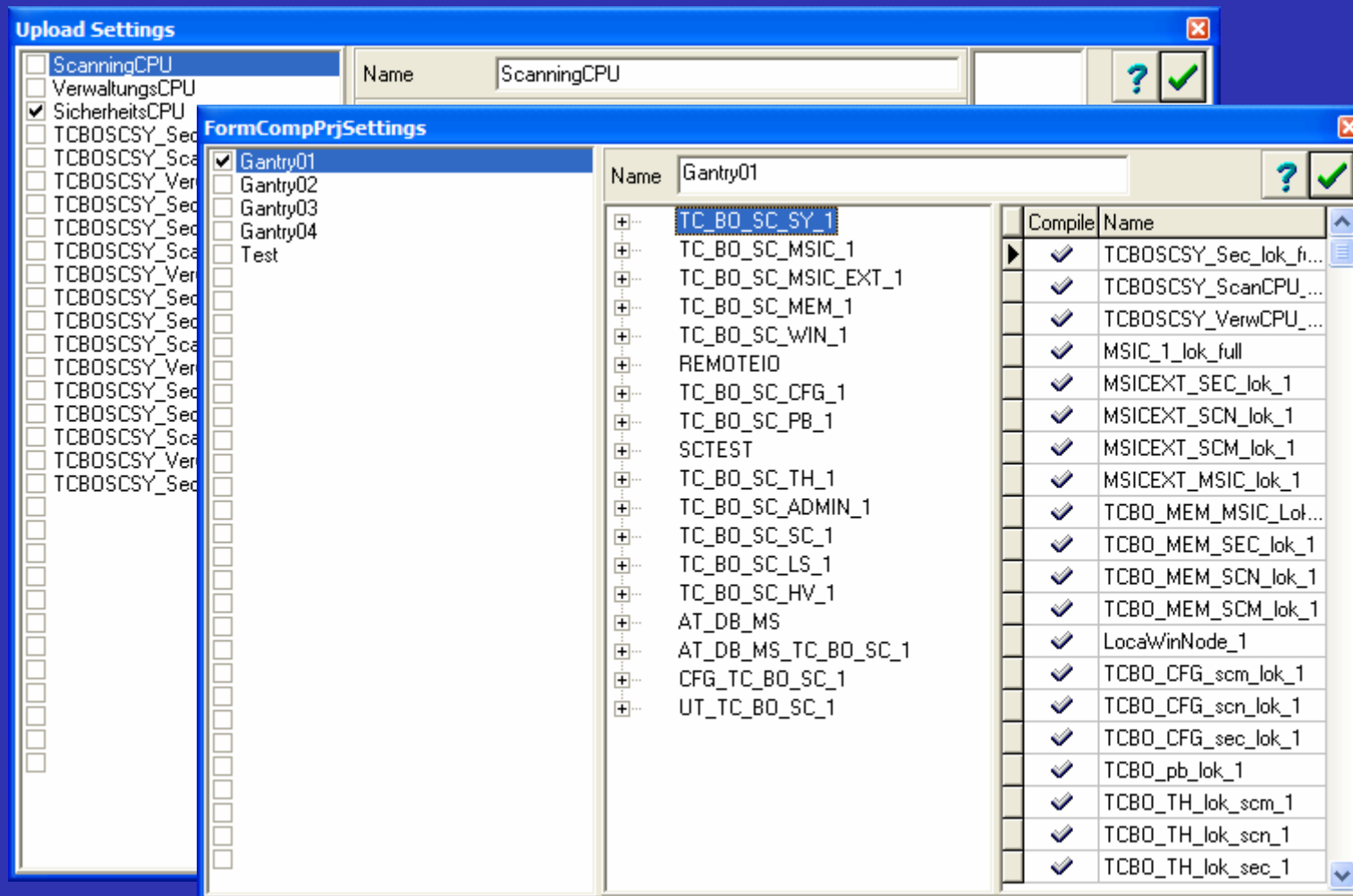
Status: Actual Display: Databases

Test Interfaces

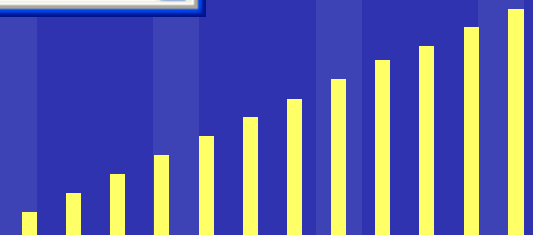


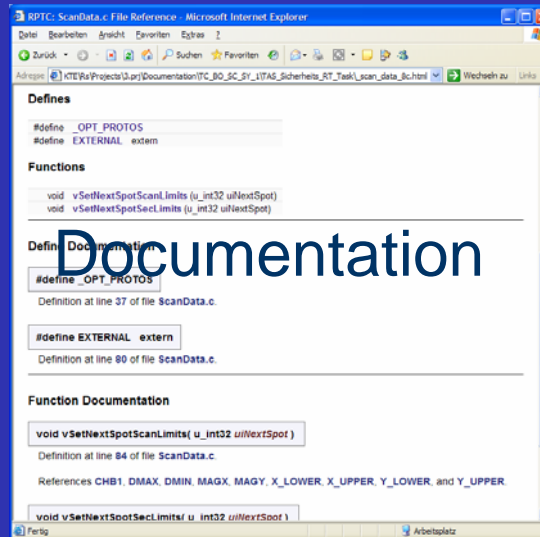
OPC
OLE for Process Control

Project compilation



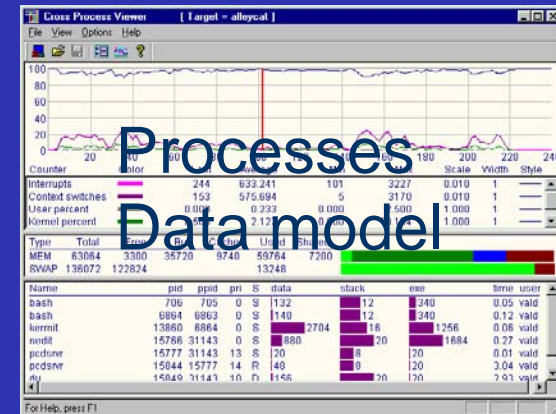
Fully automatic project compilation
Long time stable and effective



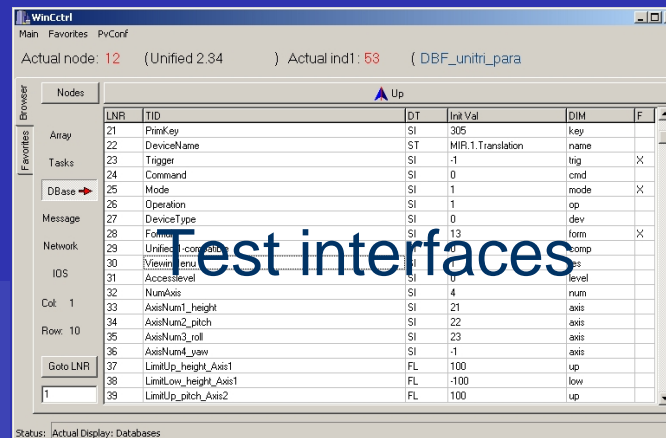


Documentation

Transfer demon



Processes Data model



Actual node: 12 (Unified 2.34) Actual ind1: 53 (DBF_unitri_para)

Nodes	LNR	TID	DT	IntVal	DIM	F
Array	21	PrintKey	SI	305	key	
Tasks	22	DeviceName	ST	MIR.1.Translation	name	
	23	Trigger	SI	-1	trig	X
	24	Command	SI	0	cmd	
DBase	25	Mode	SI	1	mode	X
	26	Operation	SI	1	op	
Message	27	DeviceType	SI	0	dev	
	28	Form	SI	13	form	X
Network	29	Unified 2.34	SI	0	comp	
	30	Viewing	SI	0	as	
	31	Accesslevel	SI	0	level	
Col: 1	32	NumAxis	SI	4	num	
	33	AxisNum1_height	SI	21	axis	
	34	AxisNum2_pitch	SI	22	axis	
Row: 10	35	AxisNum3_roll	SI	23	axis	
	36	AxisNum4_yaw	SI	-1	axis	
	37	LimitUp_height_Axis1	FL	100	up	
	38	LimitLow_height_Axis1	FL	-100	low	
	39	LimitUp_pitch_Axis2	FL	100	up	

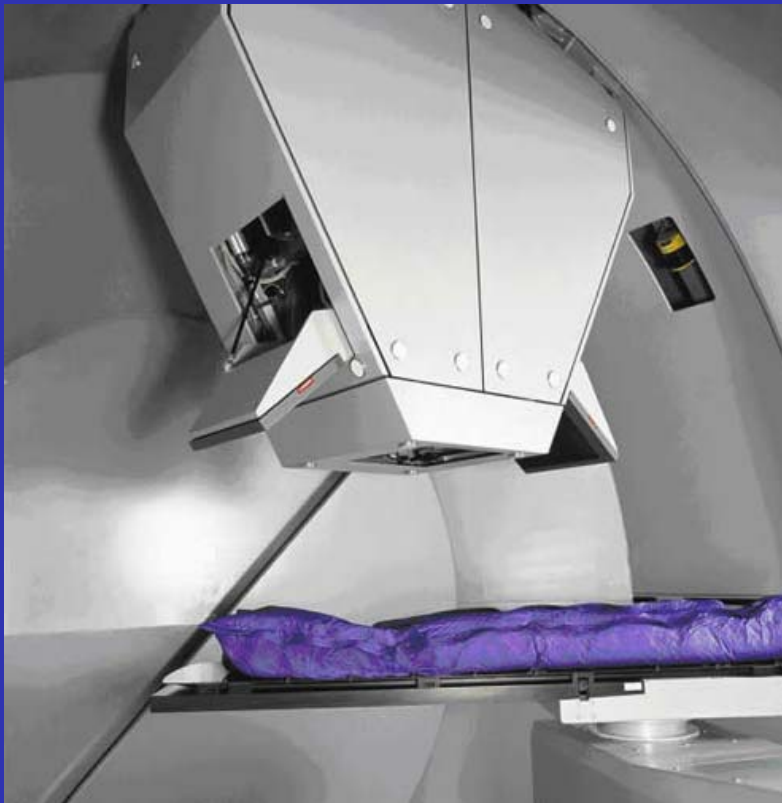
Status: Actual Display: Databases

Test interfaces

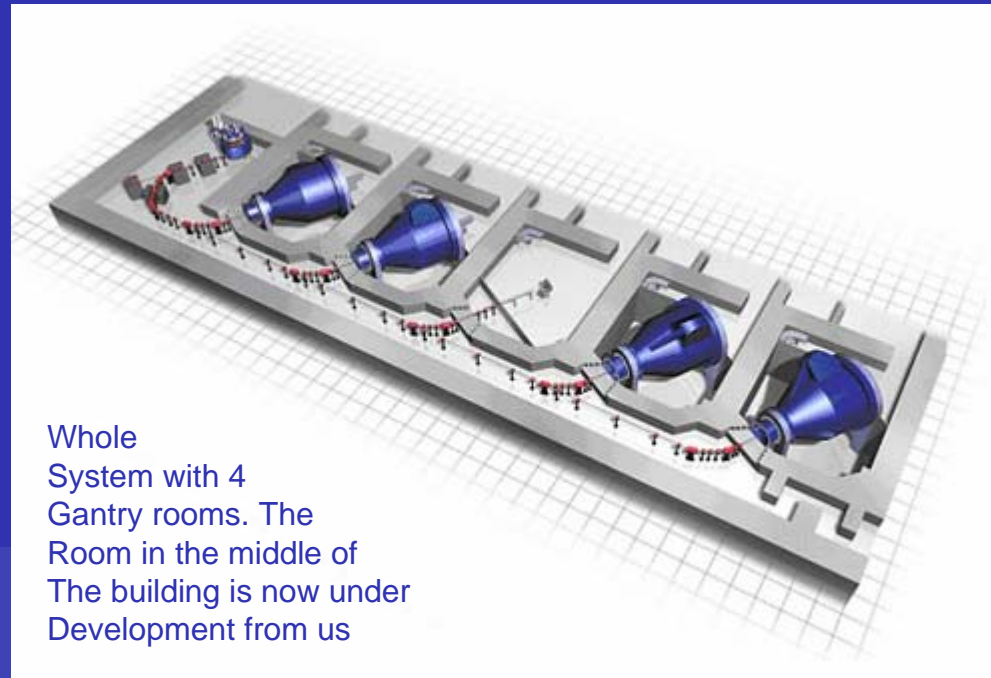
The System



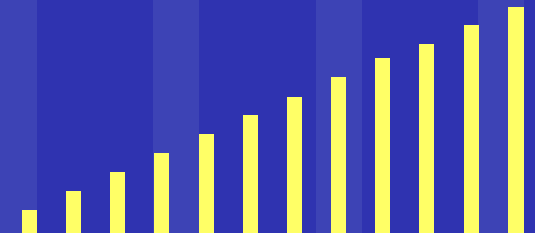
Proton therapy center for Rinnecker private clinic in Munich
Our job is beside others the beam control directly by the patient



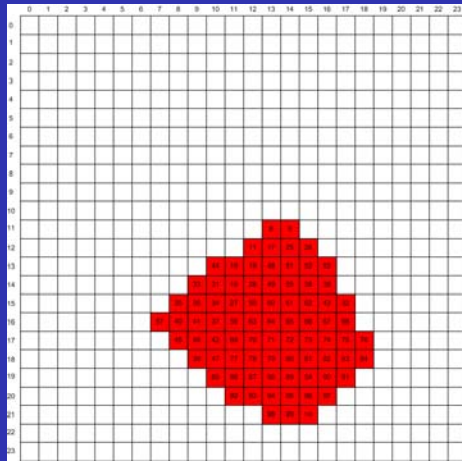
Gantry Control System



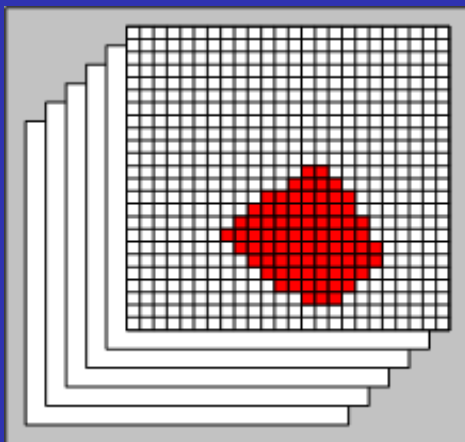
Whole
System with 4
Gantry rooms. The
Room in the middle of
The building is now under
Development from us



Scan principle



- A scan consists of a layer
- a treatment consists of several layers
- every layer has a different depth in the tissue
- using this method the tumor will be completely scanned.
- the surrounded tissue will be not irradiated and therefore not damaged



Requirements to the system

- Real-time cycle time up to $50\mu\text{s}$
- Guaranteed beam switch off within $250\mu\text{s}$
- redundant control of the beam and the beam control
- parallel working VME Systems
- High speed Networking
- Therapy control
- Communication to a Therapy control system
- Redundant data acquisition and analysis.
 - beam profile control
 - Magnet control and monitoring
 - Dose measuring and monitoring
 - additional I/O measuring and control



Design / Risk analysis



Kapitel 1.	Titel Globale Strukturen			
Thema	RPTC Scanning Kontroll System			
Teil von	DV Grobkonzept			
Projekt	PN0210107-02			
Datum	29.10.2003	Dokumentennummer	RST-107-02-DG-09	Version 1.33

Datum	Verfasser	Geprüft		Freigegeben Projektleitung
		Technisch	Qualität	

Historie:

Datum	Verfasser	Kapitel	
201003	SJG	9.0	Erster Entw
291003	SJG	1.0	Umstellung

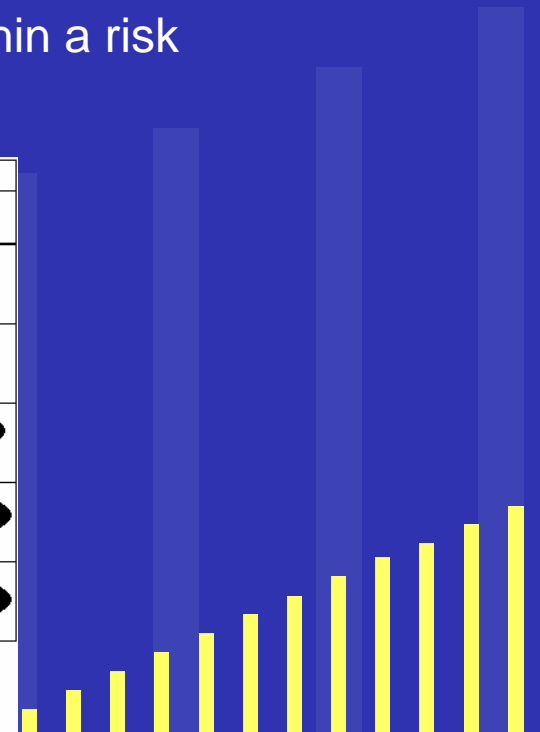
System design designed according to a
Corresponding System requirement

Risk analysis within a risk
management

Auftritts- wahrscheinlichkeit	Schadensausmaß				
	katastrophal 5	höchst kritisch 4	kritisch 3	geringfügig 2	unwesentlich 1
Die Fehlerursache tritt häufig auf 5	I	I	I	II	III
Das Auftreten der Fehler- ursache ist wahrscheinlich 4	I	I	II	II	III
Die Fehlerursache tritt ge- legentlich auf 3	I	II	II	2 → 1	III
Das Auftreten der Fehlerur- sache ist unwahrscheinlich 2	II 1 → 1	II 1 → 1	II 6 → 8	III 8 → 10	III 10 → 10
Das Auftreten der Fehlerur- sache ist unvorstellbar 1	III 10 → 10	III 4 → 5	III 1 → 2	III 7 → 7	III 2 → 2

Anzahl der Risikobewertungen vor Berücksichtigung zusätzlicher Maßnahmen: XX

Anzahl der Risikobewertungen nach Berücksichtigung zusätzlicher Maßnahmen: XX



Project setup

Project Environment (C:\GPROJEKTE\Rs\Projects\RPCTC)

Projects

- Demoprojekt
- LUK
- RPCTC**
 - TC_BO_SC_SY_1
 - TC_BO_SC_MSIC_1
 - TC_BO_SC_MSIC_EXT_1
 - TC_BO_SC_MEM_1
 - TC_BO_SC_WIN_1
 - REMOTEIO
 - TC_BO_SC_CFG_1
 - TC_BO_SC_PB_1
 - SCTEST
 - TC_BO_SC_TH_1
 - TC_BO_SC_ADMIN_1
 - TC_BO_SC_SC_1
 - TC_BO_SC_LS_1
 - TC_BO_SC_HV_1
 - AT_DB_MS
 - AT_DB_MS_TC_BO_SC_1
 - CFG_TC_BO_SC_1
 - UT_TC_BO_SC_1
- Test
- Testprojekt
- FUS
- WST
- GAMMA
- MCT
- Schott
- Blackboxtest
- Datenmodelltest
- Eltromat
- ANKA2
- Schulung
- AVNET
- test
- Datenbanktest
- EyeNozzleKontrollsystem
- IOTEST

Node Name	Node TID	LNODE	VP	Version
		1		4
		2		4
TC_BO_SC_SY_1	SicherheitsCPU: HWS.1	130		4
TC_BO_SC_MSIC_1	MSIC: HWS.4	131		4
TC_BO_SC_MSIC_EXT_1	External MSIC Access	132		4
TC_BO_SC_MEM_1	StaticMemory	123		4
		7		
		8		
TC_BO_SC_WIN_1	Schnittstelle zu TC BO SC	101		4
		10		
REMOTEIO	Hardwaretestnode	101		0
		102		
		103		
TC_BO_SC_CFG_1	ConfigurationNode	125		
TC_BO_SC_PB_1	Profibus Node	126		
		16		
		17		
		18		
SCTEST	PBinTestNode	18		
		941		
		201		
		22		
		140		
		203		
		25		
		26		4
		27		
TC_BO_SC_TH_1	Therapy and Commission	121		
TC_BO_SC_ADMIN_1	VerwaltungsCPU: HWS.3	122		4
TC_BO_SC_SC_1	ScanningCPU: HWS.2	129		4
TC_BO_SC_LS_1	LocalSpotData	128		

Setup of the project data and the system areas
Documentation of the system areas

Data model

Project Environment (C:\GPROJekte\Rs\Projects\RPTC\TC_BO_SC_CFG_1\ARRAY\TC_BO_SC_DOSIS)

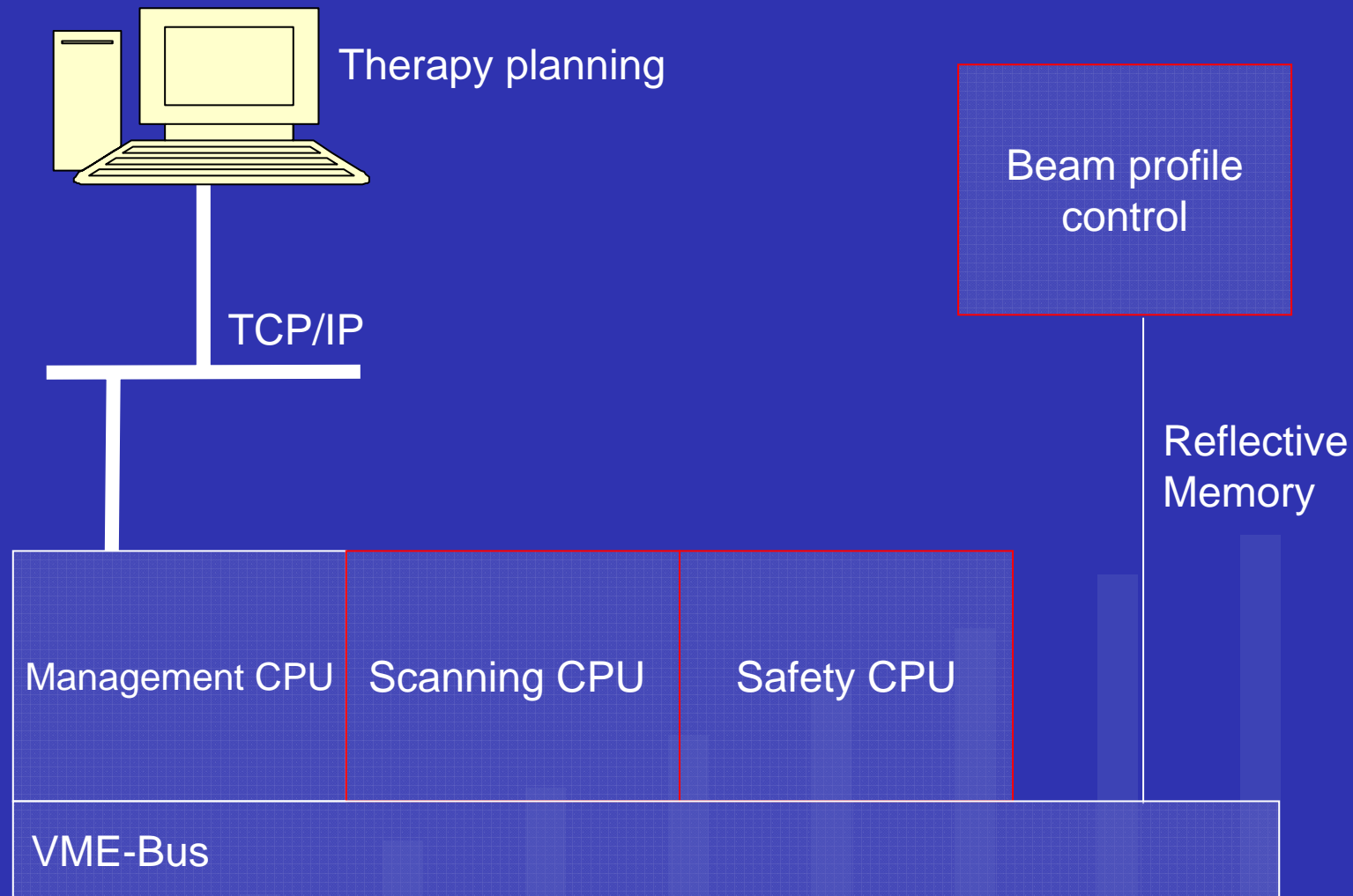
Demoproject
LUK
RPTC

- TC_BO_SC_SY_1
- TC_BO_SC_MSIC_1
- TC_BO_SC_MSIC_EXT_1
- TC_BO_SC_MEM_1
- TC_BO_SC_WIN_1
- REMOTEIO
- TC_BO_SC_CFG_1
 - ARRAY
 - TC_BO_SC_ID
 - TC_BO_SC_SCAN
 - DBINFO
 - SN_IC_01_PS_01
 - SN_IC_02_PS_01
 - TC_BO_SC_MSIC_GRAD_X
 - TC_BO_SC_MSIC_LIM_GRAD_X
 - TC_BO_SC_MSIC_OFFSET_X
 - TC_BO_SC_MSIC_LIM_OFFSET_X
 - TC_BO_SC_MSIC_GRAD_Y
 - TC_BO_SC_MSIC_LIM_GRAD_Y
 - TC_BO_SC_MSIC_OFFSET_Y
 - TC_BO_SC_MSIC_LIM_OFFSET_Y
 - ✓ TC_BO_SC_DOSIS
 - DBASE
 - IOS
 - MESSAGE
 - NET
 - TASK
 - WINDOW
 - MAIN
 - CONF
 - TC_BO_SC_PB_1
 - SCTEST
 - TC_BO_SC_TH_1

LN	TID	Init Val	DIM	DT	VP
1	TC_BO_SC_DOSERATE_OFF_TIC1	100	offset	SS	
2	TC_BO_SC_DOSERATE_OFFLIMIT_TIC1	100	offlimit	US	
3	TC_BO_SC_DOSERATE_GRAD_TIC1	1.0	not supporte	FL	
4	TC_BO_SC_DOSERATE_GRADLIMIT_TIC1	0.5	not supporte	FL	
5	TC_BO_SC_DOSERATE_OFF_TIC2	100	offset	SS	
6	TC_BO_SC_DOSERATE_OFFLIMIT_TIC2	100	limit	US	
7	TC_BO_SC_DOSERATE_GRAD_TIC2	1.0	not supporte	FL	
8	TC_BO_SC_DOSERATE_GRADLIMIT_TIC2	0.5	not supporte	FL	
9	END_OF_PARA	0	end	SI	
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					
27					

- Setup a node
- Generation of data areas and variables
- Independent of the Operating system
- No specific computer assignment
- Defining the kind of communication
 - Networks
 - Shared Memory
 - Static Memory
 - Reflective Memory

System structure



System structure over Gamma objects

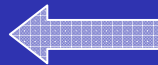


Therapy planing



Therapy
measured data

Management CPU

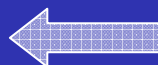


Therapy
Parameter setting

Therapy
treatment

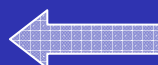
Profibus
Connection

Scanning CPU



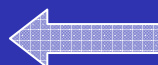
Irradiation

Safety CPU

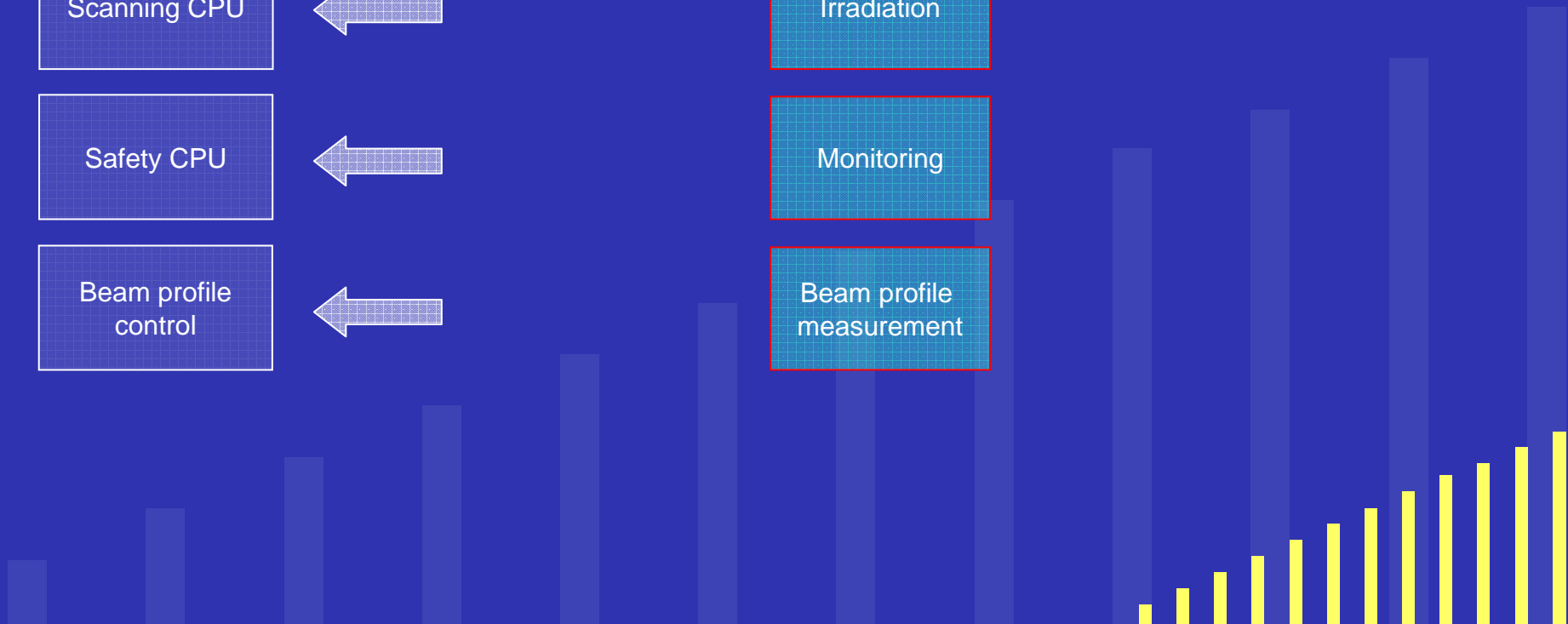


Monitoring

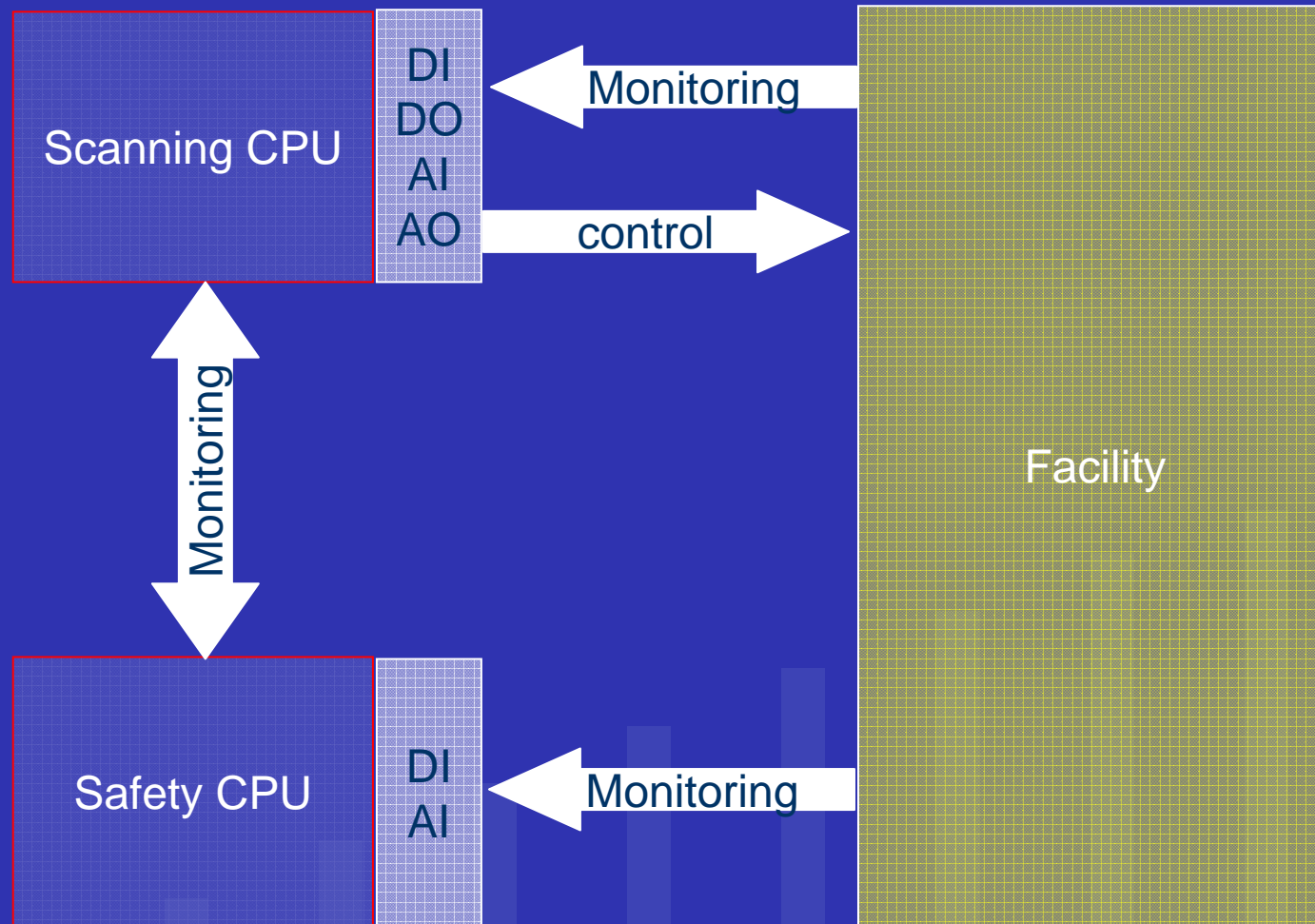
Beam profile
control



Beam profile
measurement



Redundant acquisition



Testing



WinCtrl

Main Favorites PvConf

Actual node: 12 (Unified 2.34) Actual ind1: 53 (DBF_unitri_para)

Nodes Up

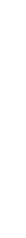
	LNR	TID	DT	Init Val	DIM	F
Array	21	PrimKey	SI	305	key	
	22	DeviceName	ST	MIR.1.Translation	name	
Tasks	23	Trigger	SI	-1	trig	X
	24	Command	SI	0	cmd	
DBase	25	Mode	SI	1	mode	X
	26	Operation	SI	1	op	
Message	27	DeviceType	SI	0	dev	
	28	Formula	SI	13	form	X
Network	29	Unified-1-compatible	SI	0	comp	
	30	ViewinMenu	SI	1	res	
IOS	31	Accesslevel	SI	0	level	
	32	NumAxis	SI	4	num	
Col: 1	33	AxisNum1_height	SI	21	axis	
Row: 10	34	AxisNum2_pitch	SI	22	axis	
	35	AxisNum3_roll	SI	23	axis	
	36	AxisNum4_yaw	SI	-1	axis	
	37	LimitUp_height_Axis1	FL	100	up	
	38	LimitLow_height_Axis1	FL	-100	low	
	39	LimitUp_pitch_Axis2	FL	100	up	

Goto LNR

1

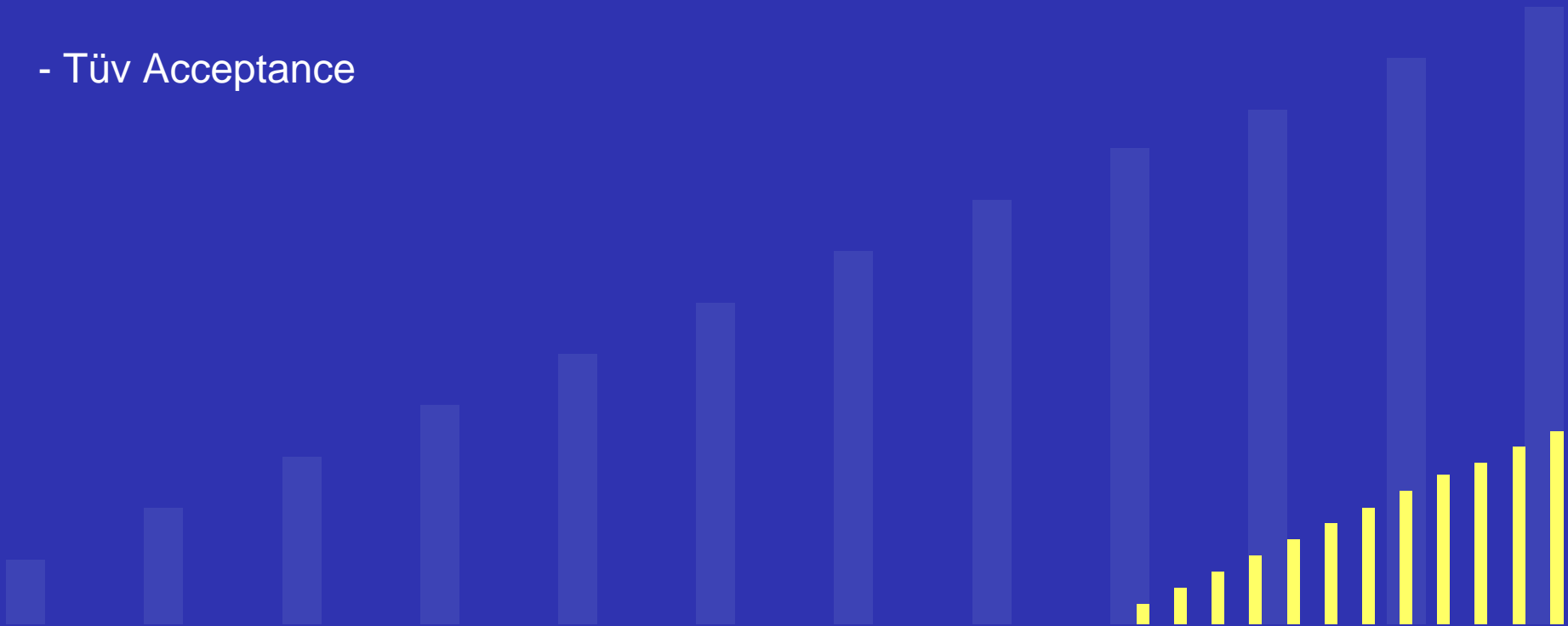
Status: Actual Display: Databases

- Blackbox Test using the Data model
- Whitebox Test
- Test Drivers
- Code Review



Commissioning / Acceptance

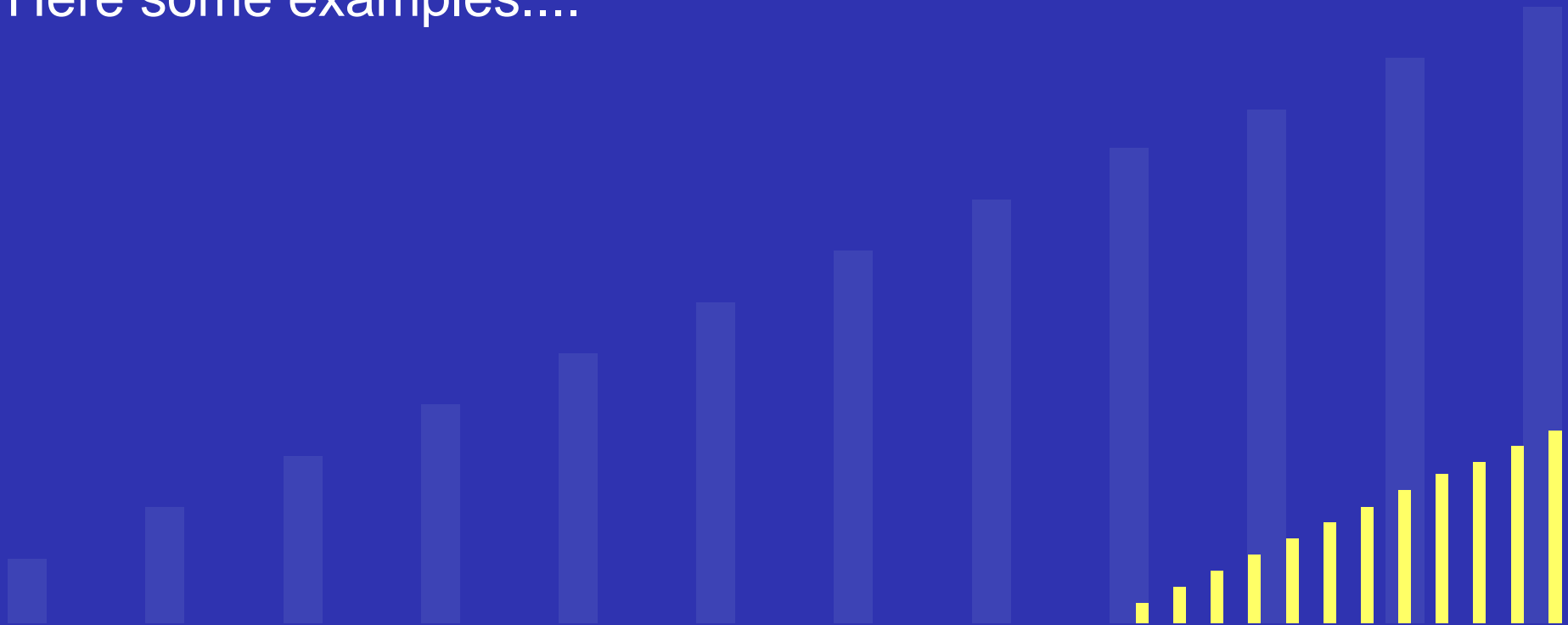
- Commissioning according to protocols
- Testing lists
- Timing Tests on the whole facility
- Formalized Acceptance protocol
- Tüv Acceptance



Market Segments and Applications

In more than 150 different projects have we shown our competence:

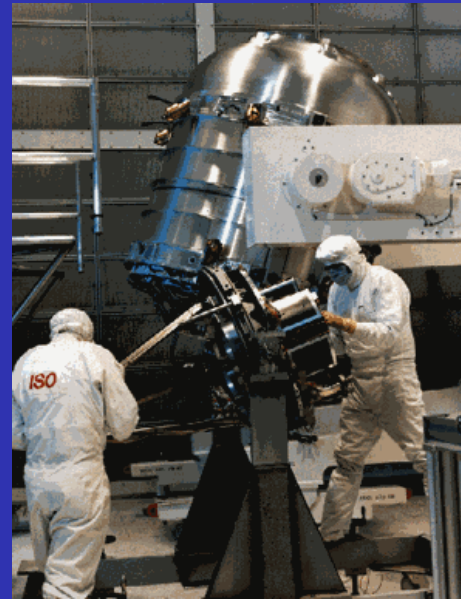
Here some examples....



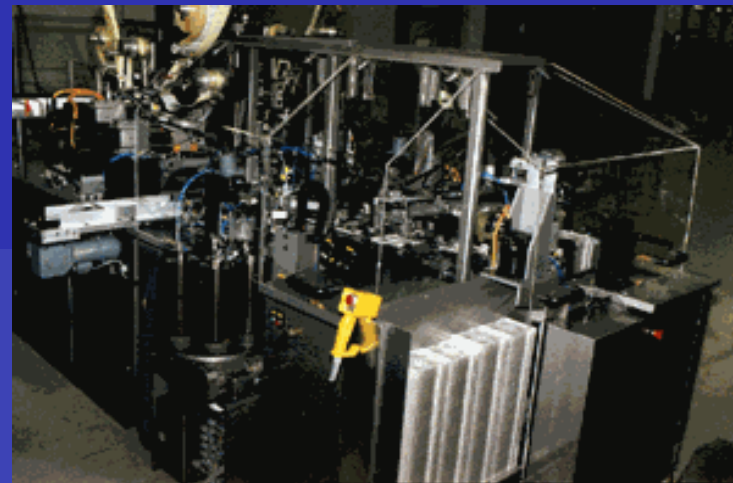
Common



Surface control



Satellite programming aerospace

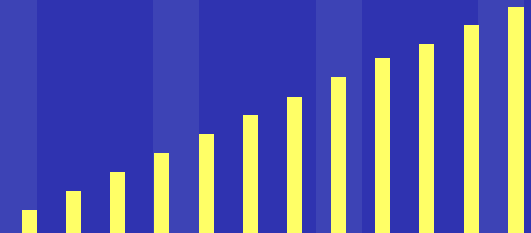


CD Packing machine

Beamline Control System

Hard- und Software based on VME and PC base.

**Forschungszentrum Karlsruhe
Anka**



National University of Singapore SSLS



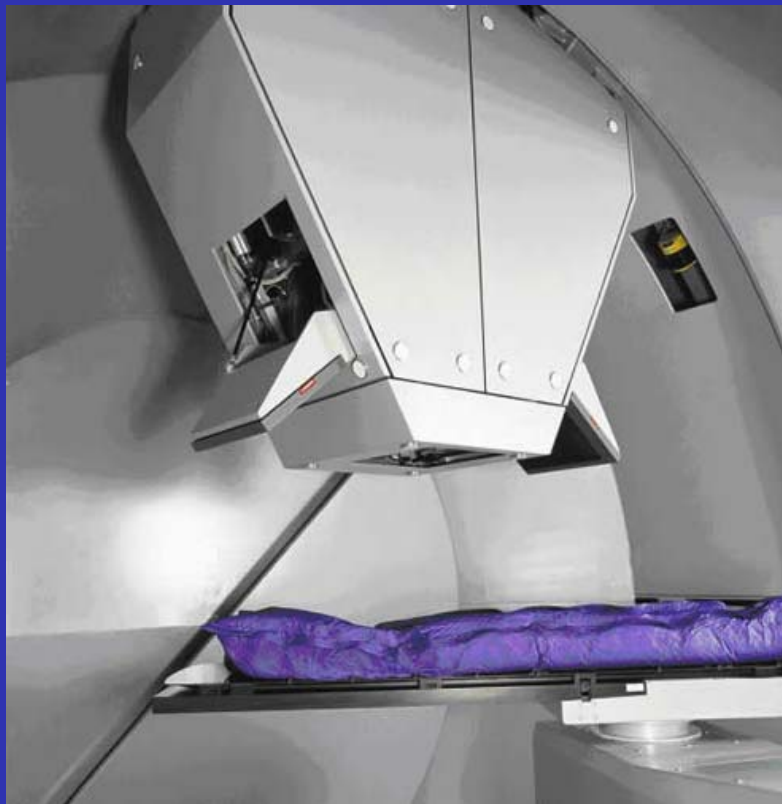
Singapore Synchrotron Light Source SSLS



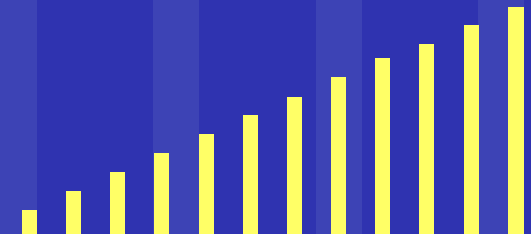
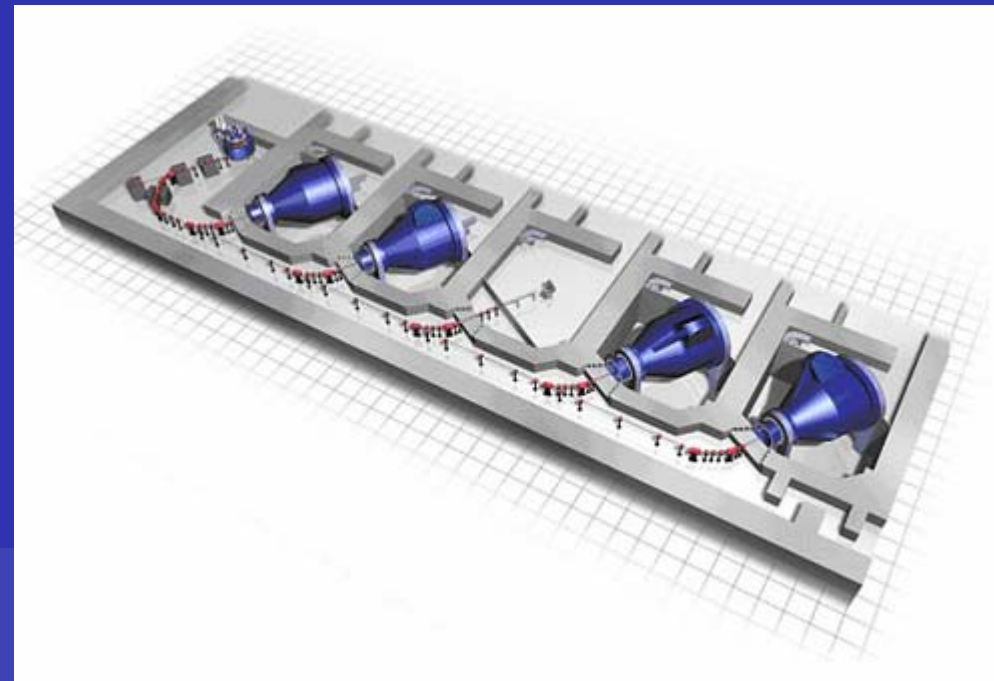
Medicine technology

RINECKER PROTON THERAPY CENTERS

München & Köln



Gantry Control System



Other Projects:



Laser control system to watch the platforms in underground stations

(General Electric)

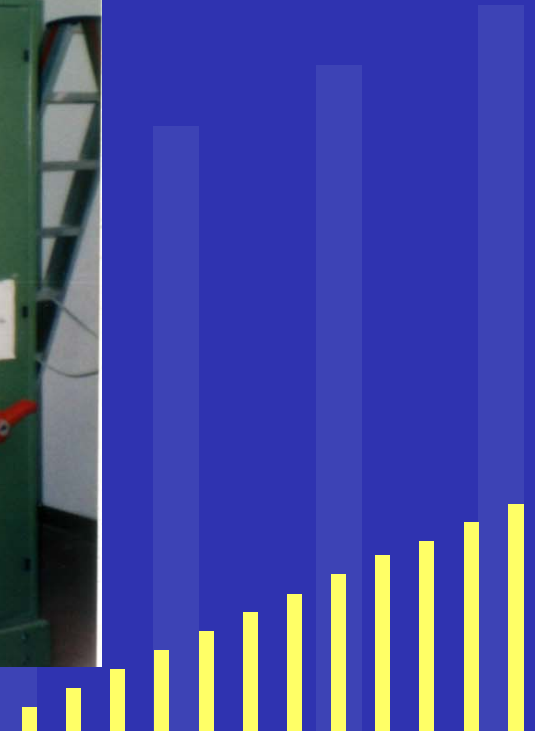


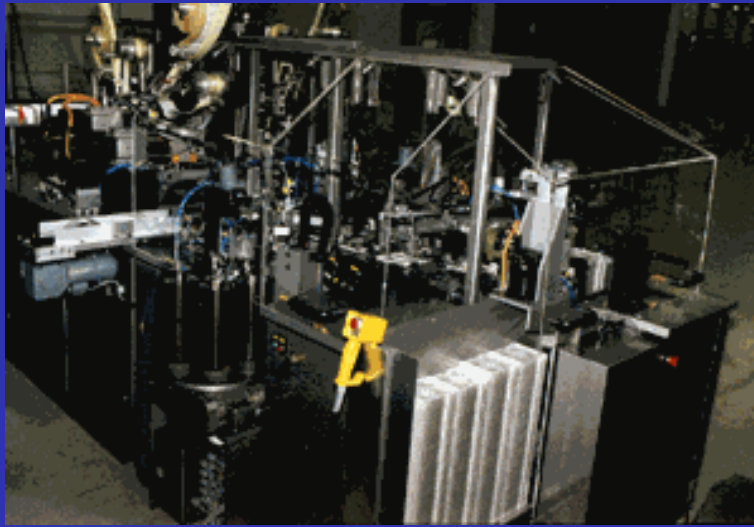
Bicycle rent system with SMS, developed with Gamma Railway Netherland

Textile industry

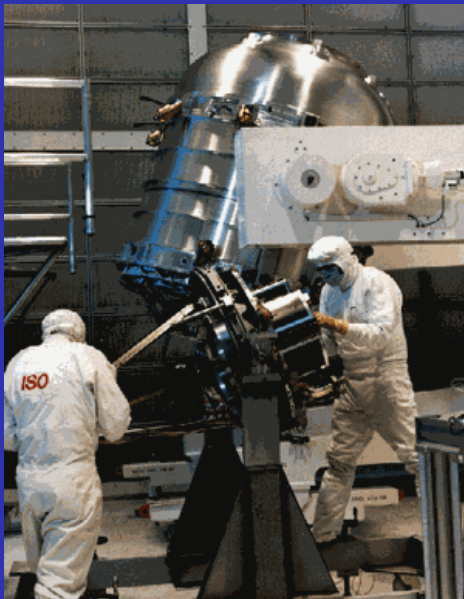


Complete Solution spinning machine firm Suessen AG
130 embedded CPU's per machine connected via CANBus





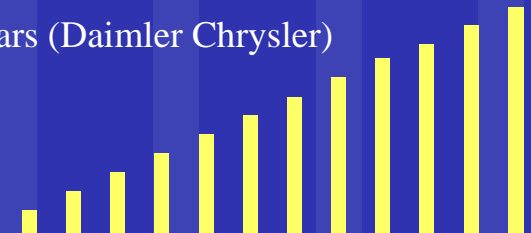
CD package system

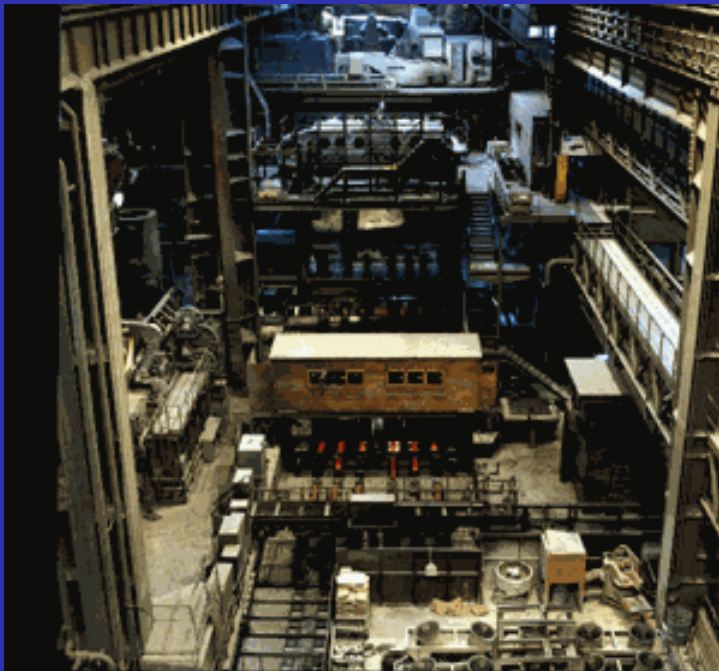


Assisting the development of a x-ray satellite



Surface check system for varnish by cars (Daimler Chrysler)

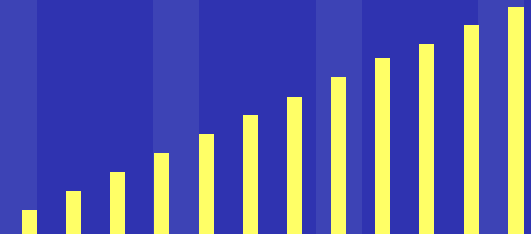




Realisation of a Converter Control system for the steel factory Saarstahl AG



Industrial bar-code control systems (Saarstahl AG)



Printing industry



Industrial Drive Control firm Wiedeg

Portation from PSOS+ VME to OS9000

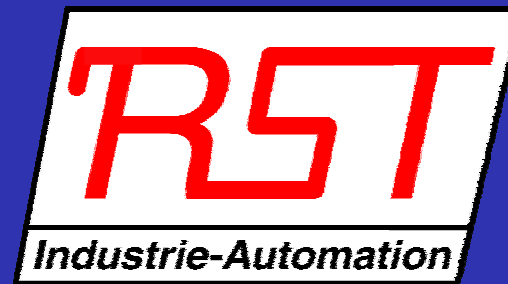
PowerPC Improvement in using Gamma
Components



Printing machine for firm Aurentum

Complete gamma solution.





In working together, RST with its extensive experience and its national and international contacts could be a very interesting partner

